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Impacts of historical climate and land cover changes on fine particulate matter (PM_{2.5}) air quality in East Asia between 1980 and 2010

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Supplementary Materials (SM)

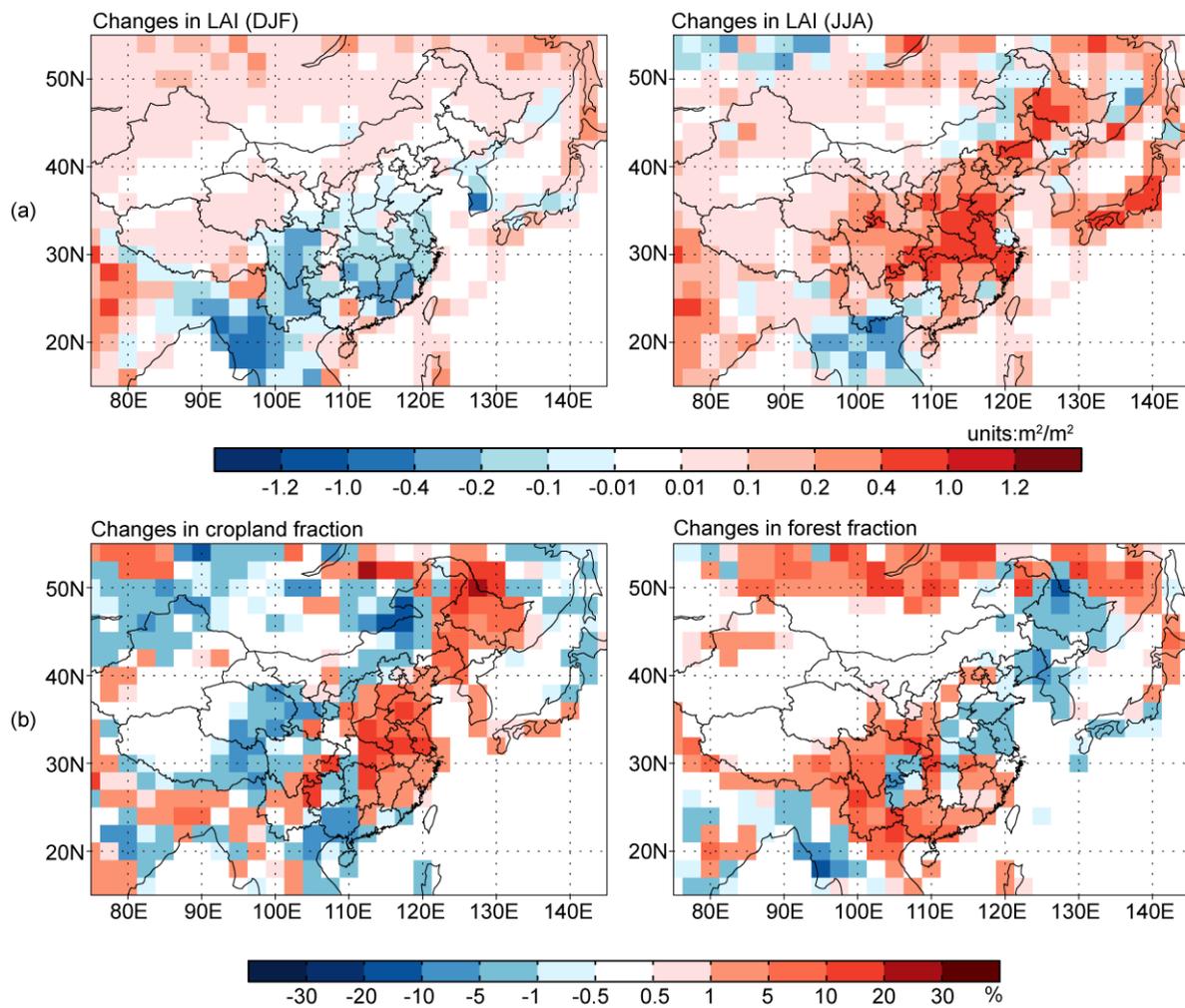


Fig. S1. (a) Changes in wintertime (DJF) leaf area index (LAI) and summertime (JJA) LAI between 1980 and 2010. (b) Changes in fractional coverage of croplands, and forests between 1980 and 2010, which are shown in Fu and Tai (2015).

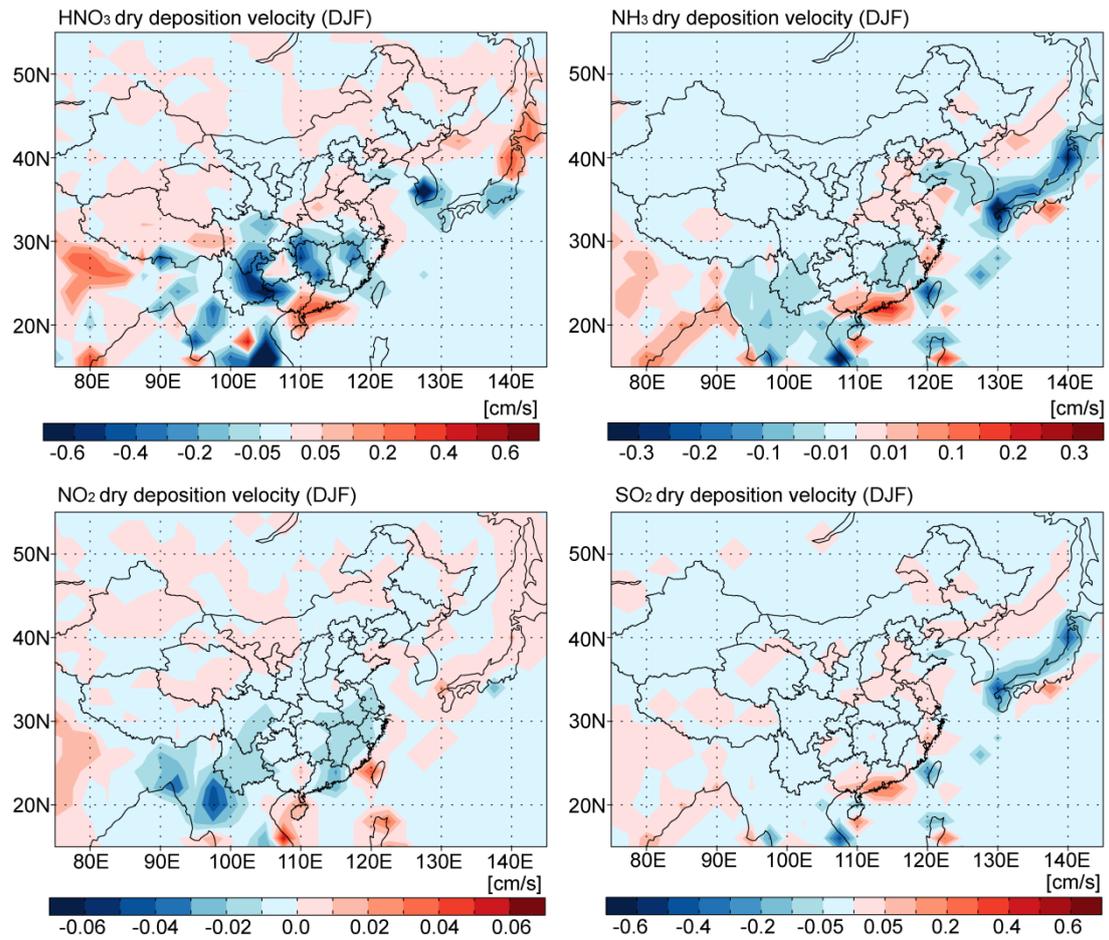


Fig. S2. Changes in dry deposition velocities of HNO₃, NH₃, NO₂, and SO₂ in winter as a result of land cover and land use change alone between simulation [CTRL] and simulation [S_LCLU].

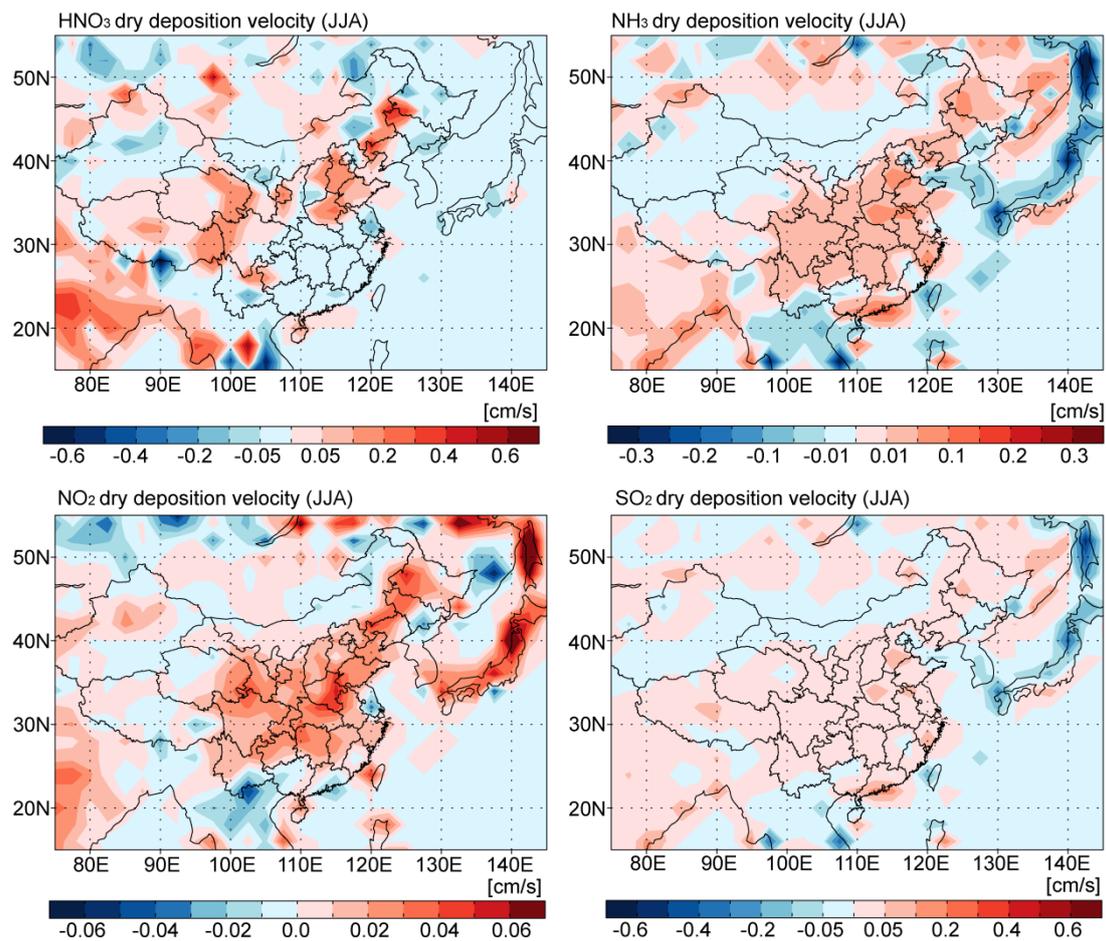


Fig. S3. Changes in dry deposition velocities of HNO₃, NH₃, NO₂, and SO₂ in summer as result of land cover and land use change alone between simulation [CTRL] and simulation [S_LCLU].

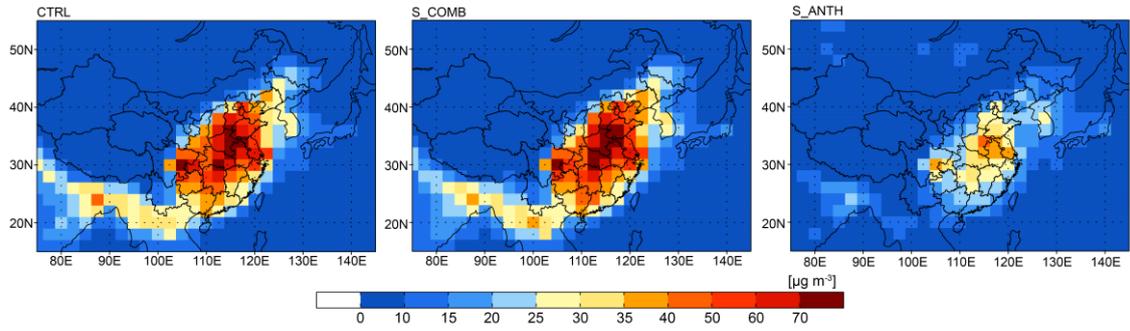


Figure. S4 Annual mean concentration for PM_{2.5} from simulations [*CTRL*], [*S_COMB*], and [*S_ANTH*].

Table S1. Regional annual mean concentrations for PM_{2.5}, sulfate, nitrate, ammonium, organic carbon (OC), black carbon (BC), and secondary organic aerosols (SOA) in East Asia (15 °-55 °N, 80 °-145 °E) and the eastern parts of China (25 °-45 °N; 100 °-120 °E). The relative change (%) of annual mean concentrations for PM_{2.5}, sulfate, nitrate, ammonium, OC, BC, and SOA between the sensitivity simulations and CTRL are all shown for comparison.

	East Asia					Eastern Parts of China				
	<i>CTRL</i> ($\mu\text{g m}^{-3}$)	<i>S_CLIM</i> (%)	<i>S_LCLU</i> (%)	<i>S_COMB</i> (%)	<i>S_ANTH</i> (%)	<i>CTRL</i> ($\mu\text{g m}^{-3}$)	<i>S_CLIM</i> (%)	<i>S_LCLU</i> (%)	<i>S_COMB</i> (%)	<i>S_ANTH</i> (%)
PM _{2.5}	12.78	-1.6	0.2	-1.4	43.9	34.78	-0.9	0.0	-0.8	91.5
Sulfate	3.85	-2.9	-0.1	-3.0	20.0	8.47	-2.3	-0.5	-2.7	56.8
Nitrate	3.14	-2.4	0.7	-1.7	216.3	11.58	-1.3	0.4	-1.0	286.2
Ammonium	2.19	-2.2	0.2	-2.0	76.0	6.50	-1.8	0.0	-1.9	127.0
OC	3.60	2.0	-0.5	1.4	19.6	7.63	2.6	-0.5	2.2	31.9
BC	0.60	0.9	0.0	0.9	39.2	1.67	2.3	0.0	2.4	50.1
SOA	0.59	8.2	-3.1	4.5	12.1	1.07	5.5	-3.2	2.4	13.3

Table S2. Anthropogenic emissions of aerosol precursors and primary aerosols used in [*CTRL*] and [*S_ANTH*] simulations in East Asia.

Species	<i>CTRL</i>	<i>S_ANTH</i>	Change, %
NO_x (Tg N yr⁻¹)			
Anthropogenic	8.78	2.60	237.7
Aircraft	0.13	0.13	0.0
Biomass burning	0.47	0.32	46.7
Fertilizer	0.51	0.48	4.4
<i>Total</i>	9.88	3.53	179.7
CO (Tg CO yr⁻¹)			
Anthropogenic	221.07	83.71	164.1
Biomass burning	41.98	24.78	69.4
<i>Total</i>	263.05	108.49	142.5
NMVOOC(Tg C yr⁻¹)			
Anthropogenic	14.39	9.86	46.0
Biomass burning	1.80	0.98	83.8
<i>Total</i>	16.19	10.84	49.4
SO₂ (Tg S yr⁻¹)			
Anthropogenic	18.36	11.97	53.4
Aircraft	0.01	0.01	0.0
Biomass burning	0.15	0.09	70.3
Biofuel	0.11	0.07	45.0
Ship	0.48	0.45	7.5
<i>Total</i>	19.10	12.58	51.8
NH₃ (Tg N yr⁻¹)			
Anthropogenic	14.68	9.58	53.2
Biomass burning	0.35	0.26	34.9
Biofuel	0.51	0.51	0.0
<i>Total</i>	15.54	10.35	50.1
OC (Tg C yr⁻¹)			
Anthropogenic	1.25	0.68	84.1
Biomass burning	1.92	1.43	34.5
Biofuel	2.28	1.91	19.5
<i>Total</i>	5.45	4.02	35.7
BC (Tg C yr⁻¹)			
Anthropogenic	1.22	0.76	60.5
Biomass burning	0.23	0.14	70.4
Biofuel	0.62	0.52	18.4
<i>Total</i>	2.07	1.42	46.0

Table S3. Biogenic hydrocarbon emission, and soil and fertilizer NO_x emission in [CTRL], [S_LCLU], [S_CLIM], and [S_COMB] simulations in East Asia.

Species	CTRL	S_LCLU (changes, %)	S_CLIM (changes, %)	S_COMB (changes, %)
Biogenic hydrocarbons (Tg C yr⁻¹)				
Isoprene	25.28	26.28 (-3.8)	23.09 (+9.5)	24.15 (+4.7)
Monoterpenes	6.98	7.03 (-0.7)	6.53 (+6.9)	6.61 (+5.6)
Others VOC*	5.69	5.78 (-1.6)	5.31 (+7.2)	5.42 (+5.0)
Total	37.94	39.10 (-3.0)	34.93 (+8.6)	36.18 (+4.9)
NO_x (Tg N yr⁻¹)				
Soil NO _x	1.32	1.31 (+0.3)	1.19 (+10.3)	1.19 (+10.7)
Fertilizer NO _x	0.51	0.51 (+0.1)	0.49 (+4.0)	0.49 (+4.1)

* Others VOCs include methyl butenol, farnesene, b-caryophyllene, other sesquiterpenes, other monoterpenes, acetone, and lumped \geq C3 alkenes.